Bronx Zoo Fuel Cell Project
Technical Progress Report

Reporting Period Start Date: September 30, 2003
Reporting Period End Date: September 30, 2007

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New York Power Authority
123 Main Street, White Plains
NY 10601

City of New York Department of
Citywide Administrative Services

The Wildlife Conservation Society – Bronx Zoo
2300 Southern Blvd, Bronx
NY 10460

Disclaimer

Abstract

A 200 kW Fuel Cell has been installed in the Lion House, Bronx Zoo, NY. The Fuel Cell is a 200 kW phosphoric acid type manufactured by United Technologies Corporation (UTC) and will provide thermal energy at 725,000 Btu/hr

The Fuel Cell Installation project is not yet completed due to delays in the renovation of the Lion House, Bronx Zoo. The Lion House renovation is scheduled to complete in June 2008.

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Executive Summary

The New York Power Authority (NYPA) was contracted by the Department of Citywide Administrative Services (DCAS) to install a 200 kW Fuel Cell to provide power and heat for the Lion House in Bronx Zoo, NY. The fuel cell is manufactured by the United Technologies Corporation (UTC). The Fuel Cell is fueled by natural gas and produces 200 kW of electricity and thermal energy at 725,000 Btu/hr for heating the facility domestic hot water system and low pressure steam.

The fuel cell was placed in the Lion House at the Bronx Zoo in June, 2006. The zoo is operated by the Wildlife Conservation Society. The Lion House has been remodeling by the New York City Department of Design and Construction (NYCDDC). Delays in DDC's renovation of the Lion House are delaying completion of the fuel cell installation. The Lion House's renovation is expected to complete in June, 2008.

The total project cost to implement this project is $1,473,861, including a five year Operations and maintenance agreement with the fuel cell manufacturer, UTC.

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1.0 Introduction

The New York Power Authority (NYPA) was contracted by the City of New York Department of Citywide Administrative Services to install a 200 kW Fuel Cell in the Lion House at Bronx Zoo, NY. The fuel cell will operate in parallel with existing Bronx Zoo co-generation facility and with the Con Edition power grid, reduce the electric demand to the Lion House by 200 kW while also providing thermal energy at 725,000 Btu/hr. Generating clean power and heat on-site at the Lion House will allow the facility to meet its growing demand and offset the need for an expensive distribution upgrade.

2.0 Name, Address and Related Company Information

New York Power Authority
123 Main Street, White Plains, NY 10601
Corporate Switchboard: 914-681-6200

New York Power Authority (NYPA) is the largest state-owned power organization in the USA. NYPA provides some of the lowest-cost electricity in New York State, operating 18 generating facilities and more than 1,400 circuit-miles of transmission lines.

NYPA sells power to government agencies; to community-owned electric systems and rural electric cooperatives; to job-producing companies; to private utilities for resale—without profit—to their customers; and to neighboring states, under federal requirements.

NYPA's low-cost power helps support more than 400,000 jobs statewide. NYPA's business customers range from Fortune 100 giants competing in international markets to small manufacturing or service firms that are vital to local economies.

NYPA is also a national leader in promoting energy efficiency and the development of clean energy technologies and electric vehicles. NYPA commits $100 million a year to energy services, and in 2006 the total investment in these programs surpassed $1 billion.

Our energy efficiency programs have resulted in more than 1,500 energy-saving projects at local, county and state government facilities, public schools and state university campuses, saving tax dollars and energy use and reducing annual greenhouse gas emissions by more than 735,000 tons and dependence on foreign oil by more than 1.7 million barrels a year.

3.0 Production Capability of the Manufacturer

The 200KW fuel cell is manufactured by UTC Power, one of the six segments of United Technologies Corporation (UTC). UTC Power is a full-service provider of environmentally advanced power solutions. With nearly 50 years of experience, UTC Power is a world leader in developing and producing fuel cells for on-site power, transportation, space and defense applications, and a developer of innovative combined cooling, heating and power applications in the distributed energy market.

The PC 25 fuel cell power plant has been in production since 1991. Hundreds of systems have been delivered to customers around the world. They operate today in a range of locations and applications, from a police station in New York City's Central Park to breweries in Japan. UTC Fuel Cells has the proven experience to meet customers' power needs.

Proven Technolgy

The fuel cell UTC provided to this project is 200KW, phosphoric acid type PC25. It chemically reforms natural gas to a source of hydrogen. The fuel cell uses the hydrogen to create direct current (DC) voltage.

The PC25 is a factory assembled, self-contained power plant with an electrical rating of 200 kW/235 kVA. At rated power, the PC25 can provide an additional 900,000 Btus per hour for the customers hot water requirements. The complete power plant consists of a power module, air cooling module, and all connections not including customer supplied hardware.

The PC25 is designed for outdoor or indoor installation, and operates equally well in the extreme cold of Alaska or the oppressive heat of the Mojave Desert.

The PC25 operates unattended and accepts multiple Fuels including standard city-pressure natural gas.

The PC25 is proven technology with installations dating back to 1991 and total of over 4,500,000 cumulative fleet operating hours through September 2001.

UTC also provides a five year maintenance contract for the fuel cell installed in the Lion House, Bronx Zoo.

UTC Power is based in South Windsor, Conn.
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4.0 Principal Investigator(s)

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Dynamic Mechanical Contractors, Inc.
Phone: 718-328-5230

5.0 Host Facility Information

The Bronx Zoo is the largest metropolitan zoo in the United States; the Bronx Zoo comprises 265 acres of parklands and naturalistic habitats -- home to over 4,000 animals, many of which are endangered or threatened species. The Zoo contains a number of unique habitats -- areas designed to replicate the homes of their inhabitants as closely as possible. The electric and heating needs of the facility are served by an in house cogeneration facility with backup from the Con Edison power grid.

The Bronx Zoo has an onsite co-generation plant which produces up to 4 MW of power which is distributed throughout the Zoo including the Lion House via a 4.16 kV loop. Excess power not consumed at the Zoo is sold to Con Edison.

6.0 Fuel Cell Installation

The fuel cell slated for installation is a UTC Power PureCell (formerly International Fuel Cells, PC25). This unit is of the phosphoric acid type; it chemically reforms natural gas to a source of hydrogen. The fuel cell uses the hydrogen to create direct current (DC) voltage. The fuel cells inverter outputs alternate current (AC) voltage. This AC energy feeds directly in the building's 460V distribution system.

The fuel cell has advanced microprocessor controls that monitor and adjust the operation of the power plant, providing for fully automatic, remote operation. The controls include advanced diagnostic ability and the unit will call out to UTC Power when it detects a failure or trouble within a component or sub-system.

In addition to the microprocessor controls, the power plant will have a sophisticated protection relay that will perform specific protection tasks. This "utility grade" relay is necessary to meet

the electric utility specifications and the New York State Standardized Interconnection Requirements, promulgated by the New York Department of Public Service. The relay will provide reverse power, over/under voltage and over/under frequency protection.

Generation Equipment Location and Configuration

Project construction was started in January 2006 and will be finished in June 2008.

The 200 kW UTC Fuel Cell power module is located in the fuel cell room, basement of the Lion House. The fuel cell cooling module will be located outside of the building. The interconnected piping between the power module and cooling module embeds underground. The nitrogen cylinders and water treatment system will be located in the fuel cell room.

Interconnected Piping

Heat Recovery Piping - Hot water supply and return piping will be routed from the Fuel Cell low grade heat exchanger to the building domestic hot water header. High grade heat hot water supply and return piping will be routed from the Fuel Cell to the building low pressure steam generator.

City Water/ Dematerialized Water Supply – A city water supply line in the house service hot water boiler room will run to a locally installed dematerialize unit located in the east side of fuel cell room. The dematerialized water supply will be then routed to the Fuel Cell for makeup.

Nitrogen Supply Line - A rack of nitrogen cylinders will be located in the fuel cell room next to the fuel cell unit. A nitrogen supply line will be then routed to the Fuel Cell.

Natural Gas Supply - New natural gas supply line will be routed from the existing Con Ed supply line to the Fuel Cell.

7.0 Electrical System

The Bronx Zoo has an onsite co-generation plant which produces up to 4 MW of power which is distributed throughout the Zoo including the Lion House via a 4.16 kV loop. Excess power not consumed at the Zoo is sold to Con Edison.

A new transformer being installed during the Lion House reconstruction will drop the loop voltage from 4.16 kV to 480 V to feed the Lion House. The 200 kW output of the fuel cell, also at 480V will directly supply Distribution Board # MDPH in the Lion House.

8.0 Thermal Recovery System

A portion of the building domestic hot water will be directed through the fuel cell low-grade heat exchanger (located in the power module) by a pumping system. The water will be heated up to 120F, and then directed back to the main piping through a three way temperature control valve.

High-grade heat hot water (at 230F) will be circulated through a low pressure steam generator by a pumping system. The low pressure steam will be utilized for humidification of the building.

9.0 Data Acquisition System

The Zoo was requested that the fuel cell power module is located in the fuel cell room in the basement of the Lion House. The unit is placed on the Teflon plates for ease of unit sliding when service is needed. The components of the fuel cell system in the fuel cell room are the water deionizer and the nitrogen cylinder storage rack. The cooling module will be the only one located outside of the Lion House in the west side of the building.

Two (2) BTU meters will be installed. One is for low heat recovery system, and one is for high heat recovery system.

Fuel Cell Ancillaries

The fuel cell has a remote radiator to dissipate heat when the Lion House hot water demand is not equal to the heat output of the fuel cell. This radiator is controlled by the fuel cells microprocessor controls and utilizes variable frequency drive motors to reduce power consumption and noise levels.

A dry nitrogen gas supply will be installed to purge the fuel cell stack of accumulated gases after a shutdown or prior to a startup.

The fuel cell requires deionized makeup water during operation. This project includes the installation of a water deionizer cylinder and resin.

10.0 Fuel Supply System

Con Edison is the natural gas utility. Natural gas is provided to the building under a variety of rates. A separate firm gas service will be provided for the fuel cell.

11.0 Program Costs

In addition to the contractor costs for installation, PB Power has included costs for electrical performance testing of the equipment, controls and safeties. This testing is necessary to satisfy Con Edison. The cost included is based on NYPA's previous experiences with other fuel cells in Con Edison territory.

NYPA Energy Efficiency - Clean Energy Technology Program
ENCORE II
Initial Customer Installation Commitment
TOTAL INSTALLED COST SUMMARY

Date: October 2, 2007

Project No.: ES-GSN-0175

Project: Fuel Cell Project at Bronx Zoo Lion House

PROJECT COST	NYPA Scope	
(1) Material Cost	$725,000	
(2) Labor Cost	$398,350	
(3) Total Material and Labor [(1) + (2)]	$1,123,350	
(4) Construction Contingency Fund [15% of (2)]	$59,753	
(5) Total Direct Construction Cost [(3) + (4)]	$1,183,103	
(6) Engineering, Design and CM [(15% of (2)+(4))+$15,000]	$83,715	
(7) AUTHORITY Overheads [12.5% of (5)]	$147,888	
(8) Estimated Interest During Construction * [5% of (5)]	$59,155	* Taxable Commercial Paper
(9) Total Installed Cost [(5) + (6) + (7) + (8)]	$1,473,861	

Material & Labor Cost Breakdown

WCS - BRONX ZOO FUEL CELL

LABOR COST BREAKDOWN

Item #	Item Description	Item Cost
1	Installation Bid (Dynamic Mechanical)	$ 378,000.00
2	Con Edison Application	$ 350.00
3	Con Edison Interconnect Engineering (Allowance)	$ 10,000.00
4	Electrical Interconnection Testing (Allowance)	$ 10,000.00
	Total Labor Cost	**$ 398,350.00**

Material Cost Breakdown

Item #	Item Description	Item Cost
1	(2) UTC PC25C Fuel Cells (200kW) & (2) Cooling Modules	$ 725,000.00
	Total Material Cost	**$ 725,000.00**

12.0 Operational Data and Results

The Fuel Cell unit has not been in operation.

13.0 Milestones/Improvements/Lessons Learned

PB Power has developed the following estimated schedule milestones.

Phase:	Completed by:
Begin Design	March 23, 2005
60 % design	May 20, 2005
Review	May 27, 2005
90% design	July 6, 2005
Review	July 13,2005
100% design	July 20,2005
100% design review	July 27,2005
Bidder Walk Through	August 19, 2005
Bid	September 2005
Bid evaluation	October 3, 2005
CIC Preparation	February 14, 2006
CIC approval	March 16, 2006
Contract award	March 23, 2006
Rig Fuel Cell	June 14, 2006
Final Connections /Utility Tie In	April 2008
Close out	July 2008

Lessons Learned

- This section will be filled upon the completion of the project.

14.0 Conclusions/Summary

The fuel cell installed in the Lion House, Bronx Zoo is fueled by natural gas and output 200KW electricity.

Fuel cells are very clean and quiet generators that utilize an electrochemical process rather than a conventional combustion process to produce electricity from fuel. The only byproduct in the fuel cell exhaust is water. The 200KW Phosphoric Acid Fuel Cell designed for this project operates with the electrical efficiency of 40%. By utilizing the waste heat produced by the fuel cell, this project is expected to operate with a total efficiency of over 70%.

The fuel cell will operate in parallel with existing Bronx Zoo co-generation facility and with the Con Edison power grid, reducing the electric demand to the Lion House by 200 kW while also providing thermal energy at 725,000 Btu/hr. Generating clean power and heat on-site at the Lion House will allow the facility to meet its growing demand and offset the need for an expensive distribution upgrade.

The total project cost to implement this project is $1,473,861. This total project cost includes interest during construction that is applied to the total material and labor during the construction period. This interest is estimated to be $59,155.

15.0 Photographs